ALGÆ OF PONDS AS DETERMINED BY AN EXAMINATION OF THE INTESTINAL CONTENTS OF TADPOLES.

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INTRODUCTION.

During the last few years a considerable amount of research has centered around the food taking of small fresh-water fish. This work has emphasized the dependence of small fish on algæ and in turn these fish as a source of food for the game fish. In reviewing literature the writer has found comparatively little scientific work on the feeding habits of the tadpole and frog.

The tadpole as well as the small fish is an indirect source of food for the human race. Tiffany ('22) states: "For most of the young fishes examined the complete story reads: 'no phytoplankton, no gizzard shad.'" It may also be said, no algæ, no tadpole.

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METHODS.

During the summers of 1927 and 1928 one hundred tadpoles and one hundred pond collections were taken from five ponds on the campus of the University of Virginia and in the surrounding vicinity. Two of the ponds measured approximately 250 ft. x 100 ft., one 150 ft. x 50 ft., one 100 ft. x 30 ft., and one 50 ft. x 20 ft. The ponds which were studied did not have active outlets.

Two examinations of each of these ponds were made during the summer of 1927 from July 15 to August 28, and two were made during the summer of 1928 from June 20 to July 5. Each collection from a pond consisted of five tadpoles [1] which measured from

[1] Of the 100 tadpoles used in these experiments, 94 were *Rana clamitans* and 6 *R. catesbeiana*.

one and three-fourths inches to five inches long and five collections of sediment taken from the edges of the ponds. The tadpoles and pond collections were put in separate containers. Immediately after returning to the laboratory the tadpoles were killed and the intestines removed. Three slides were made of material taken from each digestive tract, one from the anterior and one from the middle regions of the small intestine, the third from the anterior region of the large intestine. A study of each of the slides was made under the high power of the microscope. The algæ from each region were identified and recorded. The pond collections were studied in a similar way. Three slides were made from each of the pond collections. The algæ from each slide were identified and recorded.

During the summer of '27 the tadpoles were collected from the pond, and then the pond collections were made without any effort to correlate the position of the tadpole and the pond collection, but in the collections made during the summer of '28 a tadpole was caught and from the same place a pond collection was made.

The Problem.

The experiments presented in this paper were not undertaken primarily for the purpose of studying the food of tadpoles, but rather in order to ascertain if the algæ found in the alimentary tract of tadpoles can be relied upon as an index to the microscopic flora of the ponds in which the tadpoles are living. In other words, does the tadpole feed on different kinds of algæ or is it selective in its feeding habits? If not selective, is it as good a collector of algæ as the investigator interested in studying them?

Experimental.

In following up this problem observations were made on four collections, made at different times, from each of five ponds. The results obtained are shown in tabular form.

By referring to Table I. it will be seen that the number of species of algæ obtained from the intestine of the tadpoles exceeded the number obtained from the pond collections in every case except two, and in these instances they were the same—the pond collections being made where the tadpoles were caught.

Attention is also called to the relative number of algæ found in

the intestines of tadpoles and the ponds from which they were taken, in large and small ponds (Table I.). It is evident that, when making collections from small ponds, the investigator is able to find most of the algæ present; whereas if the pond is a large one there is an appreciable difference between the number of species of algæ obtained by the two methods—the ratio being approximately 4:3 in favor of the tadpole.

TABLE I.

SHOWING THE TOTAL NUMBER OF SPECIES OF ALGAE TAKEN FROM THE INTESTINAL TRACT OF FIVE TADPOLES AS COMPARED WITH THE TOTAL NUMBER FOUND IN FIVE COLLECTIONS MADE FROM THE SAME PONDS.

Size of Pond.	Collections Made during Summer of 1927.				Collections Made during Summer of 1928.			
	Jun. 15–Aug. 11.		Aug. 11–Aug. 28.		Jun. 21–Jun. 27.		Jun. 27–July 5.	
	Tadpole.	Pond.	Tadpole.	Pond.	Tadpole.	Pond.	Tadpole.	Pond.
250 x 100 ft.....	50	32	59	39	63	49	58	48
250 x 100 ft.....	54	42	45	37	44	44	56	49
150 x 50 ft.....	52	46	47	44	65	56	59	46
100 x 50 ft.....	35	30	63	50	56	47	47	41
50 x 20 ft.....	35	30	46	44	47	39	44	44

As stated in a paragraph under Methods, three examinations were made of each pond collection and of each tadpole—one from the anterior region of the small intestine, one from the middle region of the small intestine, and one from the large intestine. Table II. shows the distribution of the species in different regions of the intestinal tract as compared with the total number found in the tadpole and the total number found in the pond collections. Usually more species of algæ were found in the anterior end of the small intestine, but there is not a great variation in numbers in the three regions. Most of the algæ found in the large intestine show slight evidence of having been acted upon by the digestive juices.

Even though the species of algæ found in the tadpoles outnumbered those in the pond collections, algæ which did not occur in the tadpoles' intestines were found in collections made from the pond. There was one exception, and in this case the tadpole and pond collection were taken from the same place. In this entire work only five species of algæ were found in pond collections

Table II.

Showing the Total Number of Species of Algæ Found in Different Ponds, the Number Found in Tadpoles and the Number Found in Different Regions of the Intestine.

A. S. Int., anterior end of small intestine; M. S. Int., middle region of small intestine; A. L. Int., anterior end of large intestine.

Pond.	Tadpole.	A. S. Int.	M. S. Int.	A. L. Int.
29	36	23	22	20
30	34	22	16	19
35	44	23	24	19
33	33	24	19	19
30	45	21	24	31
28	33	28	26	21
31	40	26	20	24
32	31	19	14	14
27	50	26	21	36
16	34	18	13	16
25	35	29	12	16
18	35	26	14	22
35	34	21	26	16
24	36	21	21	27
32	38	21	16	21
27	36	20	22	22
32	34	31	15	18
25	38	22	21	25
24	32	18	18	19
36	49	32	26	30

Table III.

Collections Made during Summer of 1927.

Total Number Species from Both Sources.	Percentage of Those Found in Tadpoles.	Percentage of Those Found in Pond.	Total Number Species from Both Sources.	Percentage of Those Found in Tadpoles.	Percentage of Those Found in Pond.
50	86.20	55.17	70	82.85	55.71
68	79.32	61.76	58	83.10	63.79
70	74.28	65.71	57	82.62	77.19
45	77.77	66.66	68	93.64	73.23
37	94.59	81.08	53	86.79	75.28

Collections Made during Summer of 1928.

67	94.03	73.13	64	95.31	77.50
50	88.	88.	58	96.55	84.48
66	98.48	84.84	62	95.17	74.19
60	94.33	78.33	56	100.	83.91
48	97.91	81.25	47	93.61	93.61

Showing total number of species of algæ taken from each pond, including the percentage of those obtained from tadpoles and from pond collections.

which were not also observed in the tadpoles. Evidently these species were very rare, for only one was encountered the second time. The fact that these algæ were not found in the tadpoles does not indicate, therefore, that the tadpoles refuse to eat them.

The variation in percentage of algæ from the two sources is less when pond collections and tadpoles are taken from the same place. This may be seen by referring to Table III. The pond collections made during the summer of 1928 were taken from the immediate vicinity in which the tadpoles were caught, while those made during the summer of 1927 were taken without regard to this matter.

Summary.

It is a well known fact that tadpoles feed on microscopic plants. The importance of this animal as a collector of algæ is clearly demonstrated. In comparing the intestinal contents of one hundred tadpoles with pond collections made from the same ponds, the number of species of algæ obtained from the tadpoles exceeded the number obtained from the collections in every case except two; and in these instances, they were the same. It may be stated, therefore, that an examination of the intestinal contents of tadpoles affords one of the best and easiest methods of determining the species of algæ present in ponds. This is especially true in large ponds, and applies particularly to the phytoplankton.

In this examination one hundred and seventy species and varieties of phytoplankton were found. Of this number, one hundred and sixty-five were encountered in the intestines of tadpoles.

Conclusion.

1. The food of green-frog tadpoles consists chiefly of algæ.

2. The algæ from pond collections and from the intestinal contents of tadpoles taken from the same ponds do not differ as much in small ponds as they do in the larger ones.

3. The anterior region of the small intestine is considered to be the best region for making examinations for algæ.

4. The species of algæ taken from the intestines of tadpoles constituted, on the average, 89.73 + per cent. of the total found.

5. An examination of the intestinal contents of tadpoles affords one of the best and easiest methods of obtaining a collection of algæ from ponds.

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